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ABSTRACT

A study tested two hypotheses: (1) If physical performance relates to mental performance, then aerobically fit individuals will demonstrate higher academic achievement or predicted achievement; and (2) The integrity of the cardiovascular system (as measured by distance covered in 12 minutes) will have some degree of positive association with school achievement, predicted achievement, and cognitive test scores. Randomly selected students (n=284) at Furman University (South Carolina), stratified by gender and year in school, served as subjects to test these hypotheses. All were enrolled in a required physical fitness course. Measures were taken of change in cardiovascular fitness resulting from 12 weeks of training, body fat change over the training period, and strength of the forearm muscles. Factor analysis using an oblique varimax rotation yielded three distinct factors. Grip strength and 12 minute run distances loaded heavily on the first factor, all the cognitive variables on the second, and only body fat percentage loaded on the third. No meaningful relationships were found between cognitive ability and the three physical factors. Results indicate that measures of the physical domain do not significantly improve the prediction of cognitive achievement. (JD)

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Cognitive and Physical Relationships in College Women and Men[1]

Seeking relationships among cognitive and physical variables within the species has been an often pursued line of scholarly endeavor. The ease and accuracy with which human physical characteristics can be measured has made them particularly attractive variables of study with respect to cognitive function. If an anthropometric tape measure, a stop watch or a blood sample can tell one something predictive about cognitive function, then some value exists in the further study of cognitive and physical relationships.

Human physical characteristics indicative of maturation show significant relationships with measures of cognitive function. Terman's classic studies of genius clearly indicated that physical variables were most predictive of genius in elementary school males (1925). In his large sample of boys who scored over two standard deviations above the mean on the Binet IQ test, high grip strength was a common characteristic. Schmidt (1982) reported a study where a significant correlation between the foot size of third grade students and their arithmetic achievement test scores occurred. Children with larger feet were found to score higher on the math tests. The inclusion of other predictors into the model

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seemed to clearly show that larger foot size is indeed related to the age in months of the child. Quite likely older children have had greater exposure to arithmetic skills and their sensory systems are better developed to take in such cognitive information.

Adults, defined as humans who have physically fully matured, may also function cognitively to the extent that their physical senses are well-developed. Intuitively, the quality of the physical component should have some relationship to the quality of the cognitive component. Arnett (1968) found a correlation of .56 between grade point average and a composite measure of neuromuscular fitness. He studied 827 freshman women at a state university. Hart & Shay (1964) studying a sample of sophomore women found no significant relationship between SAT math and verbal test scores and a composite index of physical fitness. Using grade point average as a measure of academic achievement, a correlation of .50 with composite physical fitness emerged ($p<.01$). With 256 male freshman Weber (1953) reported a correlation of .41 between grade point average and a neuromuscular fitness profile.

Ismail & Gruber (1967) and Ismail, Kane, & Kirkendall (1969) after most extensive analyses of physical and

cognitive variables were able to show few meaningful predictive relationships across domains. Neuromuscular skills and abilities such as hopping and balance showed some relationship to cognitive performance.

It seems reasonable to hypothesize that physical performance would relate to mental performance; that aerobically fit individuals should demonstrate higher school achievement and/or predicted achievement. It was hypothesized that the integrity of the cardiovascular system as measured by distance covered in 12 minutes would have some degree of positive association with school achievement, predicted achievement, and cognitive test scores. The magnitude of change in cardiovascular fitness resulting from 12 weeks of training was also hypothesized to relate to cognitive achievement. Body fat change over the training period was hypothesized to relate positively to academic achievement, i. e., those who worked the hardest to lose body fat would be those of higher academic achievement levels. Strength of the forearm muscles was included in the physical battery of tests as a measure of muscular fitness.

Method

From over 1000 students enrolled in a conceptually based required physical fitness course at Furman University

during 1977 to 1979, 25 percent were randomly selected, post hoc, as subjects. The sample was stratified by gender and by year in school and totaled 284 students. Descriptively, the subjects were on the average 20.1 years old, scoring 1097 on the SAT, prediciting a 2.47 grade point average on a 4.0 scale using the Educational Testing Service formula, and having actual grade point averages of 2.73. Furman is a highly selective institution and the cognitive data support the overall high level of achievement of the sample. Cognitive data were obtained from the academic records of each selected subject. Physically, the characteristics of the sample are reported in Table 1. The testing proceedures used to obtain the physical data have been verified as being reliable through high correlations between pre and post-test administrations.

Results

Factor analysis using an oblique varimax rotation yielded three distinct factors. Grip strength and 12 minute run distance loaded heavily on the first factor, all the cognitive variables on the second, and only the body fat percentage loaded on the third. Reaction time did not load significantly in any way nor did any of the change variables. Factor 1 and factor 3 were additively combined as a fourth factor, labeled physical

combination, and all four subjected to an interfactor correlation. There were no meaningful relationships between the cognitive and the three physical factors. A regression analysis using each factor as a dependent variable resulted in no more than six percent of the total variance being accounted for by any combination.

Discussion

It apppears that the inclusion of measures of the physical domain would not significantly improve the prediction of cognitive achievement in academically talented college males and females. In spite of some resonably high relationships between the domains reported in the literature, aerobic fitness seems to not only be independent of cognitive performance, but to also be independent of the physical measure of body fat. The common loading of grip strength with 12 minute run performance indicates that muscular strength is indeed related to a running test of aerobic performance. Grip strength has been found to be significantly related to total body strength as measured by a composite of other strength measures. The efforts subjects made to improve their physical fitness during a 12 week course, indicated by the change in pre to post-tests added little to the predictibility of cognitive performance. A composite measure of physical

proficiency, i. e., one that combines in some logical way each of the physical measures used in the present study as well as other measures, may show a higher relationship to measures of cognitive achievement. Physically and cognitively, the subjects in this study functioned at a very high level. It is quite probable that a subject-sample of more average physical and cognitive achievement or a sample of below average function would need to be studied to conclude unconditionally that little or no predictive relationship exists in these domains.

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	* MALES		* FEMALES		* COMBINED	
	* pre	post	* pre	post	* pre	post
	*		*		*	
SATmath	* 575		* 567		* 568	
SATverbal	* 512		* 545		* 529	
SATtotal	* 1086		* 1112		* 1097	
predictedGPA	* 2.30		* 2.55		* 2.47	
actualGPA	* 2.70	2.69	* 2.81	2.70	* 2.73	2.73
12 min run(laps)	* 6.20	6.60	* 4.70	5.20	* 5.60	6.20
percent body fat	* 15.40	14.30	* 21.20	20.10	* 17.60	17.10
grip strength(kg)	* 55.30	55.70	* 32.50	33.90	* 42.00	43.20
reaction time(ms)	* 159		* 170		* 164	

*Significant differences exist between males and females on all variables except actual GPA ($p<.01$).
All pre to post changes are significant except male and combined GPA and male grip strength ($p<.01$).